Fruit Growth Case Studies

Watering fruit trees is a bit like praying, you know it does some good, but aren't quite sure how often or how long you should do it for.

In 1992 the DPI had a field day to report on a research project they had done on irrigation apple trees. The work had been done over 3 seasons with a neutron probe. The work was done during a drought on two orchards with shallow soils. The aim was to see how little water could be used and determine a schedule for dry seasons.

They found that 1. - the more you water the more apples you pick.

2. - the more you water the larger and redder those apples are.

This local research is consistent with irrigation research findings worldwide.

To get this result they concluded that;

⇒ Early irrigation is critical (October - November).

⇒ 3 irrigations of 4 hours a week is better than one irrigation of 12 hours.

⇒ Efficiency is obtained by measuring soil moisture and measuring fruit.

In 1984 Peter Crew of the DPI reported that close planted apple trees used 280 litres of water per week in mid summer. This is 17½ hours x 16 litres/hour.

The Victorian Department estimates apples planted 2m x 5m in mid summer will use 315 litres per week. This is 19½ hours x 16 litres/hour.

The question I want to answer today is

"How much water is needed and how often should it be applied ?"

There is no blanket answer to this question because every orchard is different.

85% of Australia's irrigated cotton is irrigation scheduled with neutron probes. Despite most farms having uniform soil types, very few varieties and standardised growing methods cotton growers irrigate every paddock differently because every paddock is different and must be treated as such for high yields.

To answer the question for your situation I need to know :

1. How much soil your tree roots are using - how big is the pot they are in ?

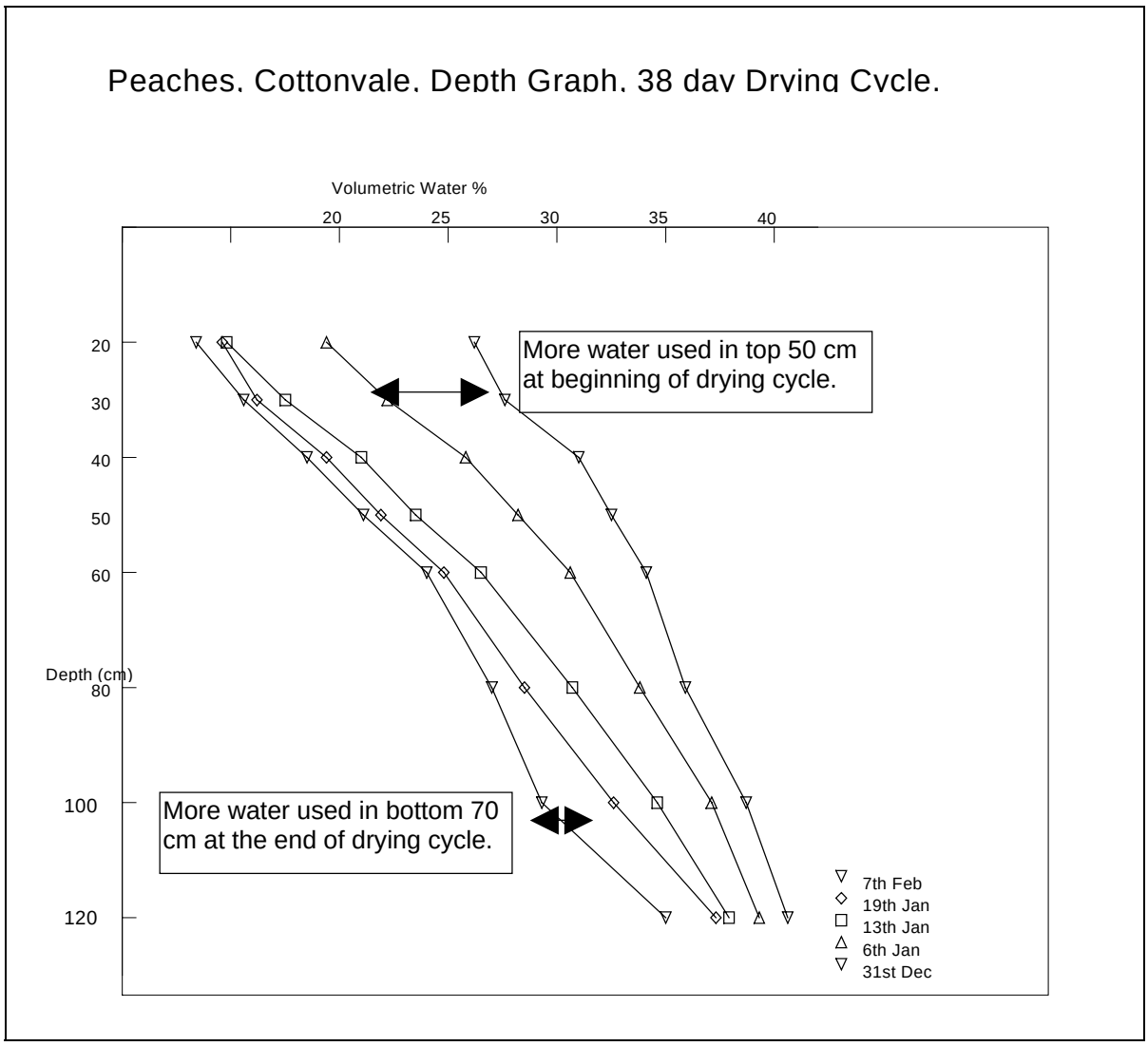
2. How much water does this pot hold ?

3. How often should the water be applied to refill the tree's pot ?

1. How big is the pot?

If you have trees spaced 5m X 2m then the simple answer is the pot has a 10 m^2 top to it - but how deep is it ? As deep as the topsoil ? Down to the clay layer ?

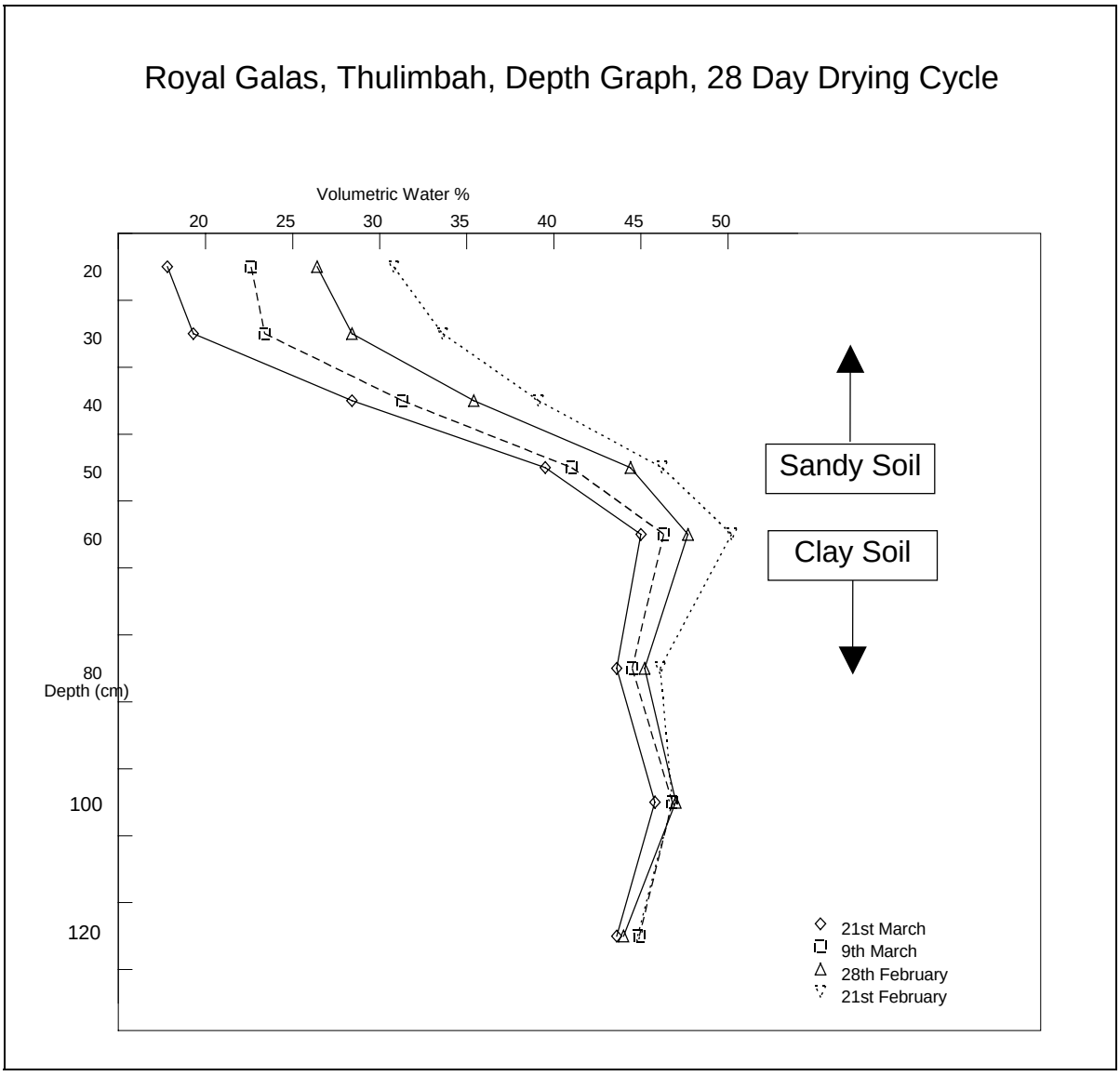
To answer this I measured how deep the roots were extracting water from a peach and Royal Gala orchards when they weren't being watered.



The peaches at Cottonvale were in a sandy soil that overlaid decomposed granite.

This graph shows that from the 31 December to 7th February the peaches were not irrigated and progressively got drier at all depths. I didn't measure deeper than 120 cm but the trees were using water deeper than this at every date. I have called the peaches pot 130 cm deep.

Water was used mainly from the top 50-70 cm in the first 14 days after irrigation stopped and mainly from the bottom 70 cm after that. When the tree is extracting water from below the area where most of the roots are then the tree is under stress, it is photosynthesising less and the soil is below the Refill Point.



The Royal Gala trees at Thulimbah were in a sandy soil that overlaid a heavy clay at 60 cm.

This graph shows that from the 21 February to 21 March the Royal Galas were not irrigated and dried out mainly in the top 80 cm but used some water down to 120 cm. I have called the pot Royal Gala pot 80 cm deep.

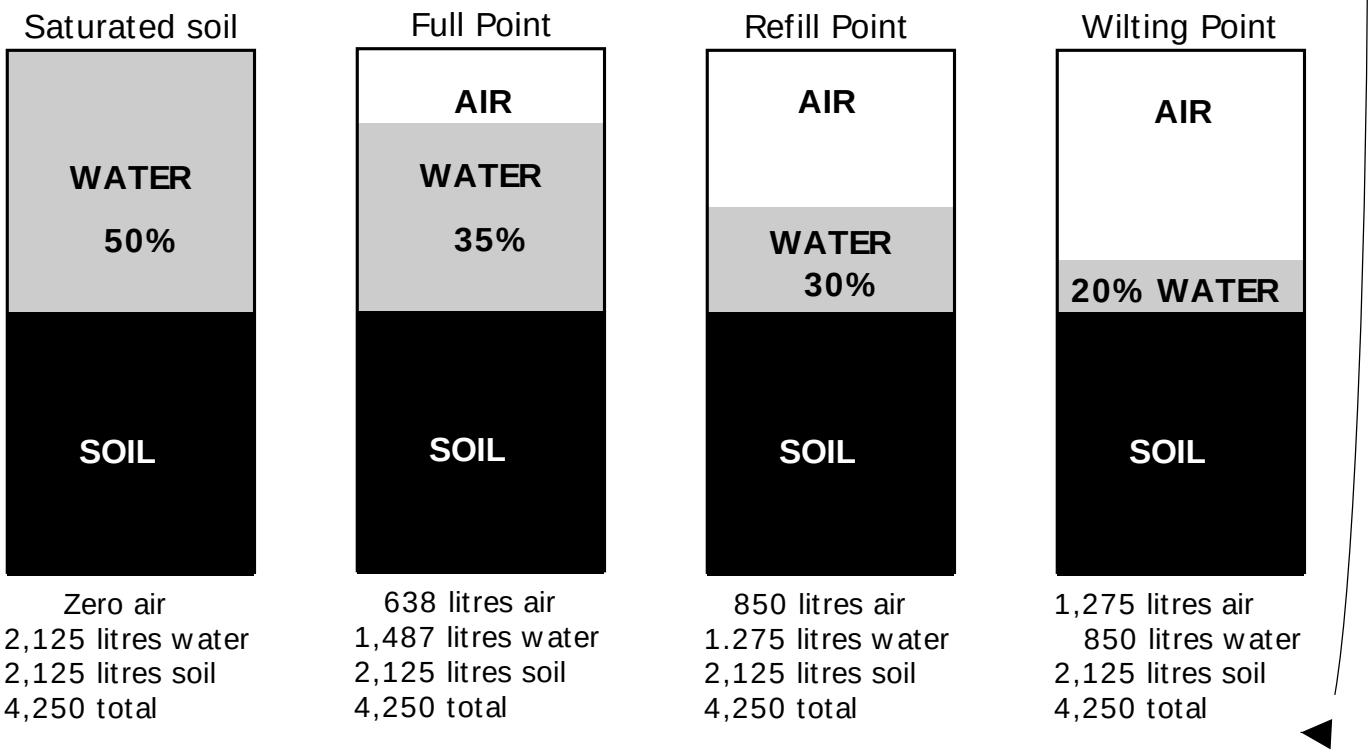
If a tree's pot is 130 cm deep and its top is 10m^2 does it have a volume of 13 m^3 ?

Probably not as the area between the tractor tyres never gets irrigated, doesn't always get fertilised and is usually compacted. Hence the roots are less plentiful and the soil there is effectively outside the pot. I have excluded this 2½ metre strip. Also there is a natural concentration of roots towards the surface so I have discounted the soil volume below 70 cm by 50% because of low root density there.

So the Royal Gala pot is (5 m^2 X 70 cm) + ½ (5 m^2 X 10 cm) = 3.75 m^3 = 3,750 litres and the peaches pot is (5 m^2 X 70 cm) + ½ (5 m^2 X 50 cm) = 4.75 m^3 = 4,750 litres

For the exercise I will average the two and say the pot is 4.25 m^3 or 4,250 litres.

2. How much water does this pot hold?



Saturated soil	Full Point	Refill Point	Wilting Point
Zero air	638 litres air	850 litres air	1,275 litres air
2,125 litres water	1,487 litres water	1.275 litres water	850 litres water
2,125 litres soil	2,125 litres soil	2,125 litres soil	2,125 litres soil
4,250 total	4,250 total	4,250 total	4,250 total

From the depth graphs the probe tells me that the difference between the Full and Refill Points is about 5% volumetric soil moisture at the depths 0 to 70 cm.

* 5% (35% - 30%) of 4,250 litres *or*

* 213 litres is the difference between Full and Refill Points.

What about waste ? If irrigating in the day some <u>evaporation</u> is unavoidable, lets add 2 %. In sandy soils some <u>deep drainage</u> usually happen because water travels quicker downwards than it does sideways. For the exercise lets add 15 %.

The soil wetting pattern is often referred to as an 'onion'. It has a bulb shape and spreads out in layers. To wet the outside layers some water is lost at the base of the onion.

250 litres of water is needed to take the tree's pot from the Refill Point to Full Point

3. How often should this water be applied to refill the tree's pot?

Because the tree is using the water gradually then this 250 litres should be replaced gradually.

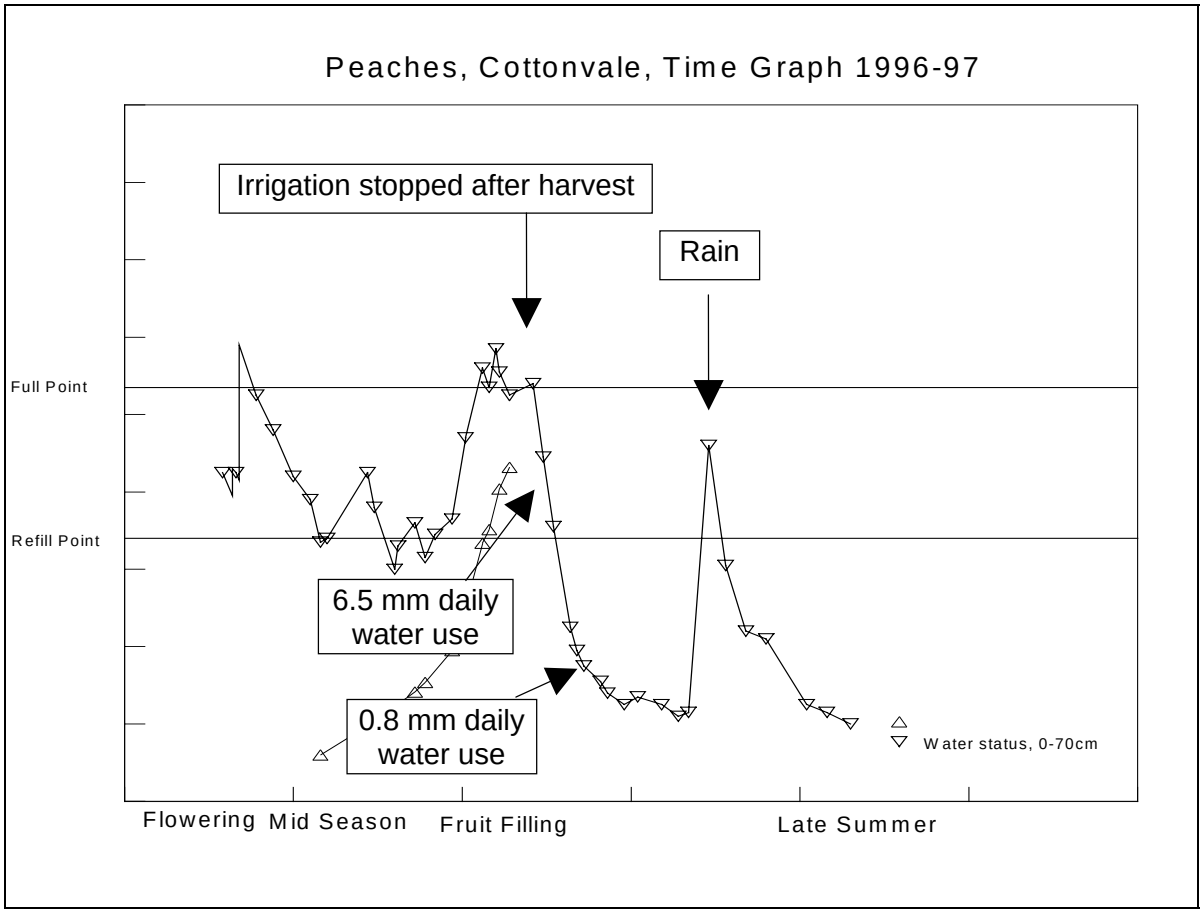
As the DPI research says 3 X 4 hours is better than 1 X 12 hours.

If the pot takes 2 days to dry, it needs 125 litres/ day or 7.8 hours/day @ 16 litres/hr.

If the pot takes 4 days to dry, it needs 62 litres a day or 3.9 hours/day @ 16 litres/hr.

If the pot takes 6 days to dry, it needs 42 litres a day or 2.6 hours/day @ 16 litres/hr.

The number of days a tree takes to dry its soil depends on the weather, the variety and the amount of leaves on the tree.



The peaches at Cottonvale were not irrigated after they were harvested and the soil progressively dried out until it rained again. Note that in the first four days after the water was turned off the

peach trees used 6.5 mm/day water. In the next 5 weeks they only used 0.8 mm/day water. Why ? Because the available soil water had run out.

Local Fruit Growth Case Studies

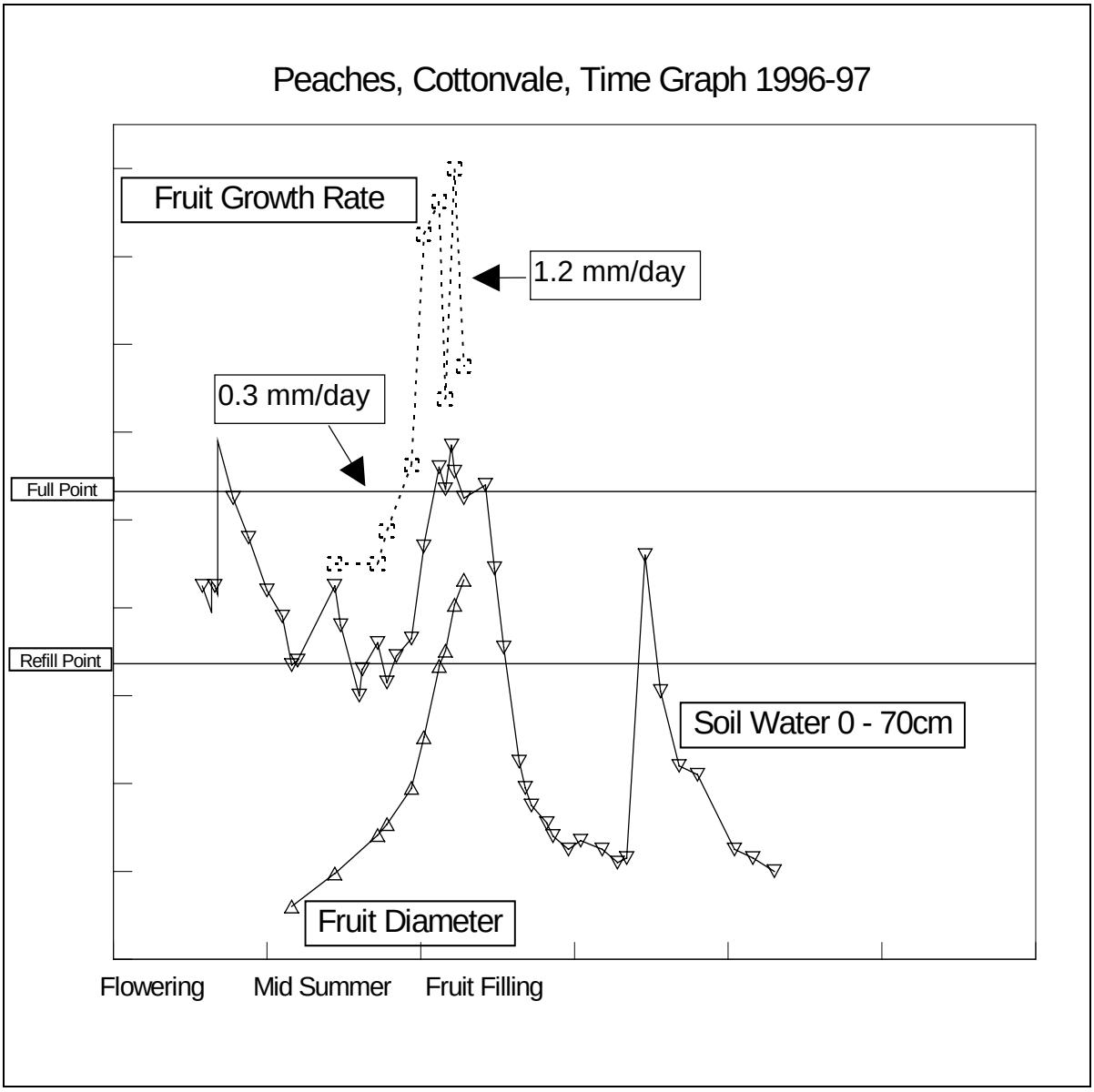
How does this plant water use relate to fruit growth ?

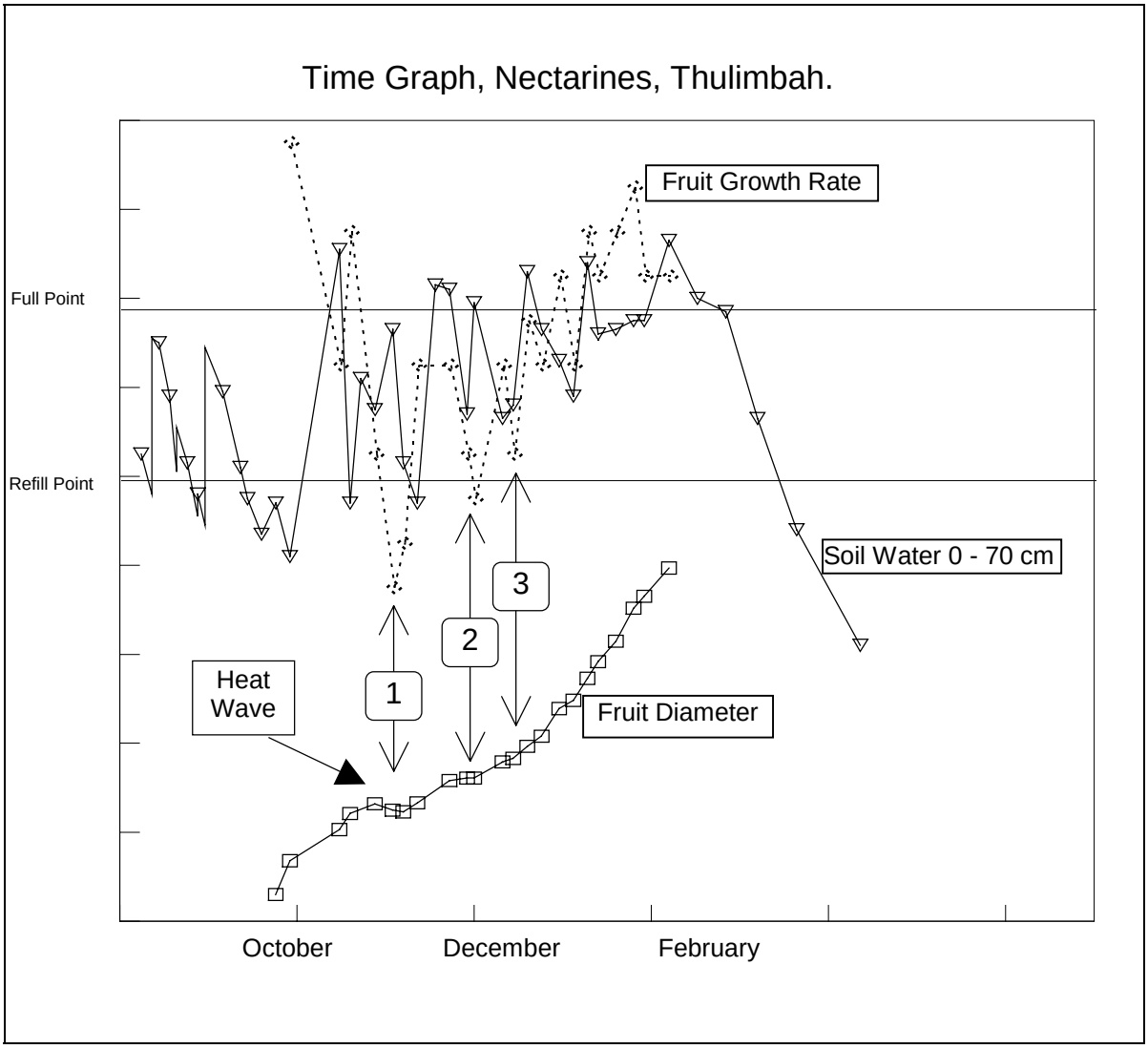
Five local examples from the 1996-97 season will show how fruit in trees in soil near the Full Point grow faster than those on trees near the Refill Point.

A good sized apple is 75 mm (count 110). If a young Delicious fruitlet is 3 mm in diameter after the petals fall on the 18th October and it is harvested on 28th February it has 133 days to grow 72 mm. This is a growth rate of 0.54 mm per day.

Can this growth rate be practically measured ? Yes, the growth rates I measured last season ranged from 0.1 mm/day to 1.4 mm/day.

Stonefruit grow rapidly towards the end of their season whilst apples grow most rapidly in the middle of their season.


Peaches, Cottonvale, Time Graph 1996-97
Fruit Growth Rate
1.2 mm/day
0.3 mm/day
Full Point
Refill Point
Soil Water 0 - 70cm
Fruit Diameter
Flowering
Mid Summer
Fruit Filling



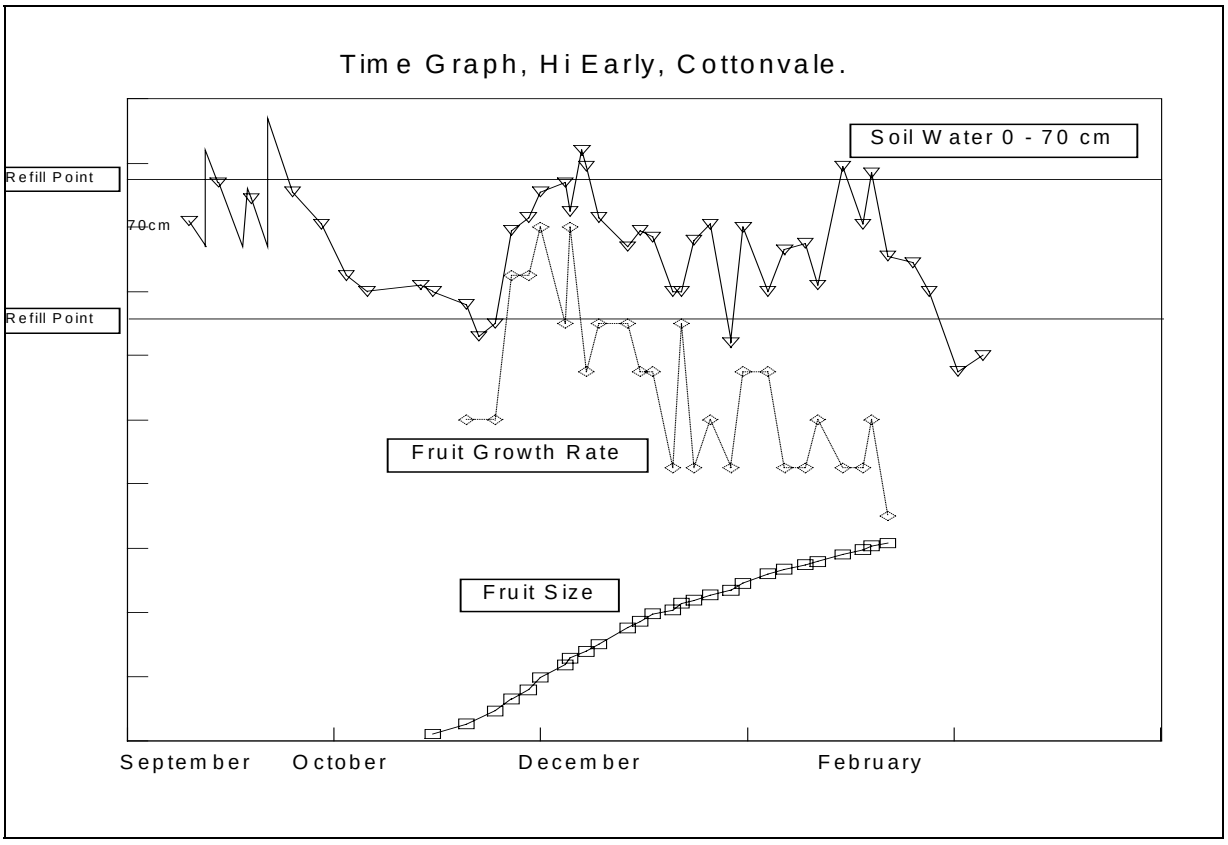
There were three periods when the fruit growth rate was low.

1 was at the end of November - start of December when the maximum temperature was over 30^{o} C for 7 days, and the trees shut down under heat stress. Note that the soil water was high (because the orchard was being irrigated) but the growth rate was actually negative as fruit shrunk.

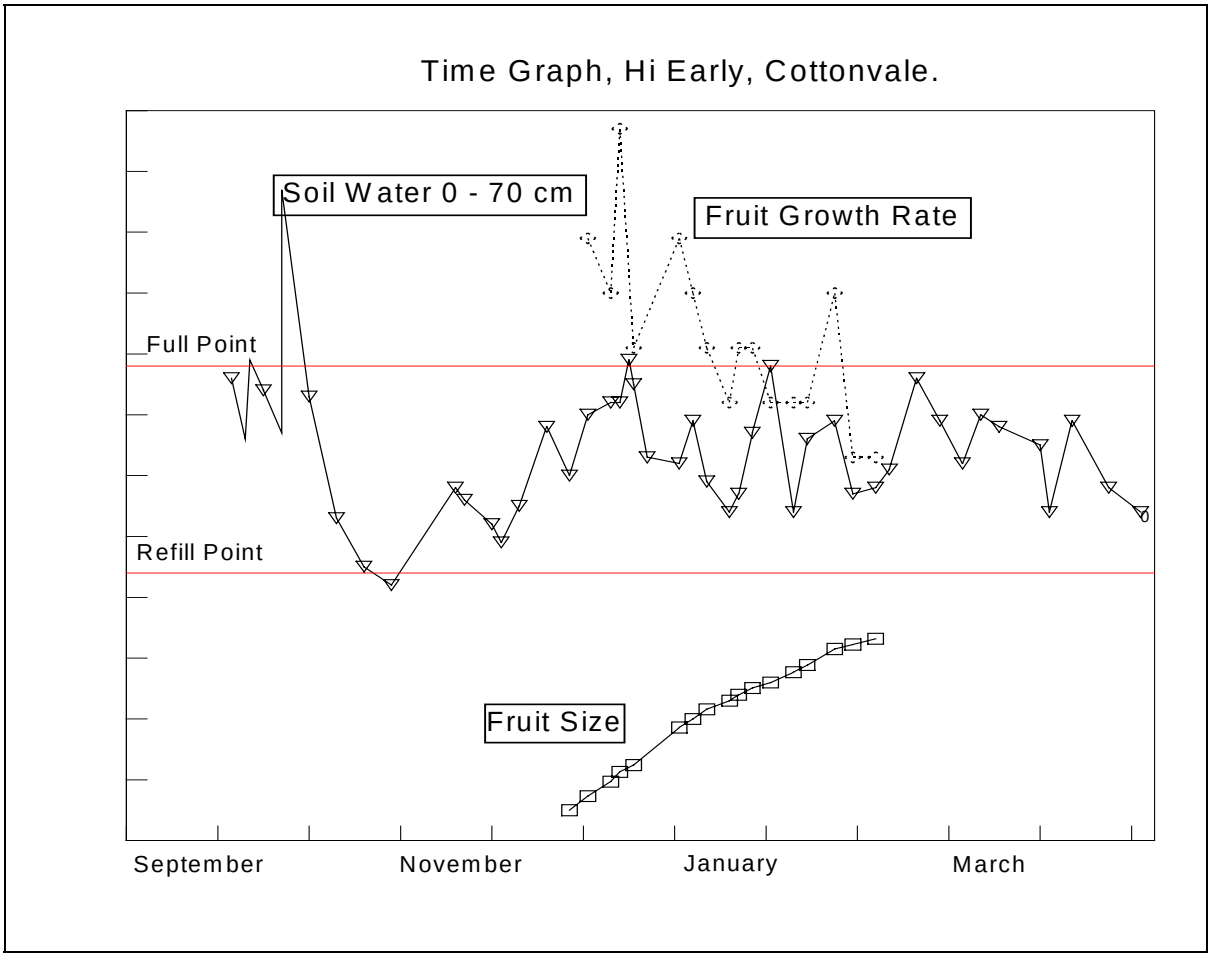
2 & 3 were periods when soil water was too low for too long and the fruit growth rate dropped from 0.5 mm/day to 0.1 mm/day. These two periods combined amount to 10 days at a disadvantage of 0.4 mm/day or a total loss of size of 4 mm by harvest.

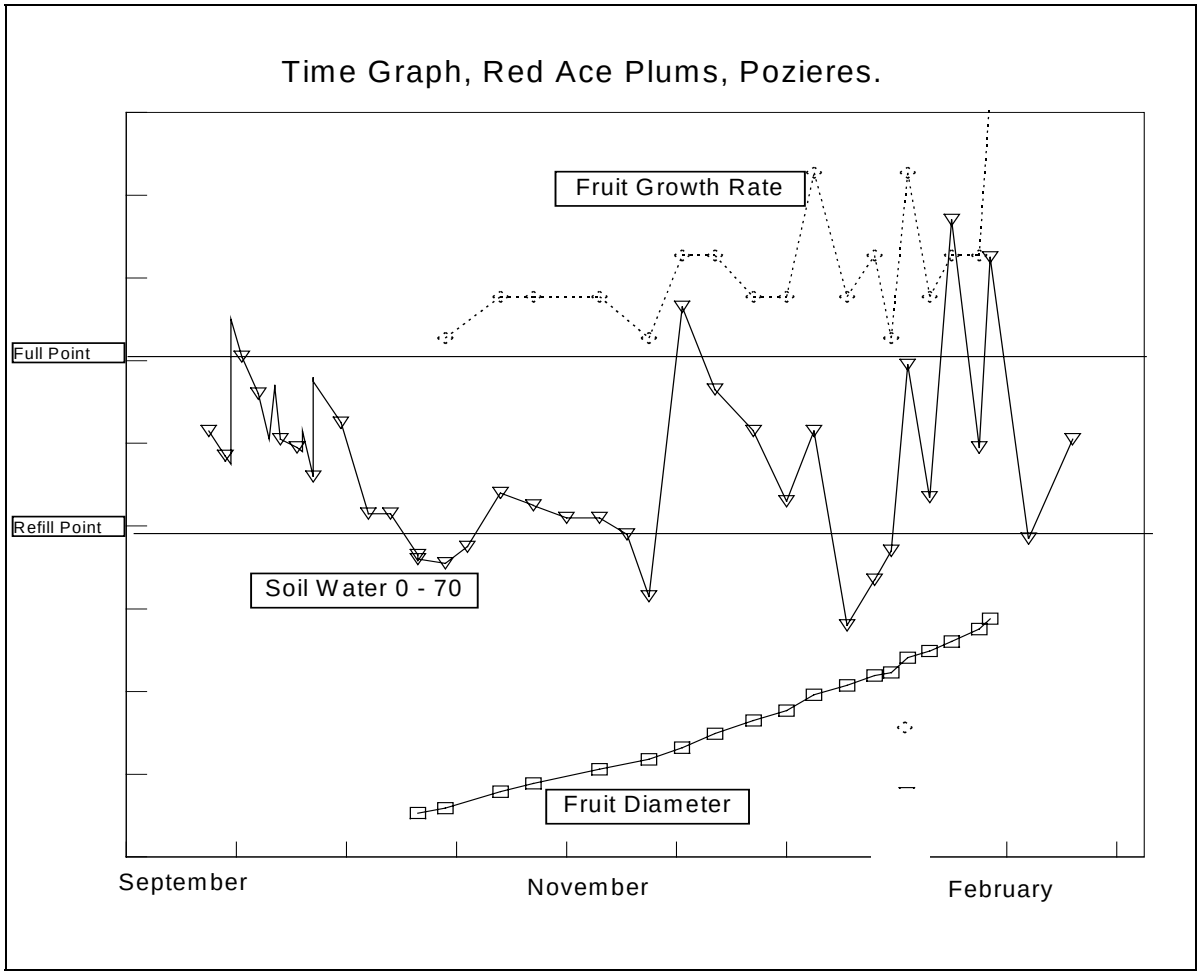
Note that after periods of slow or no growth there is no catch-up spurt of rapid growth.

Fruit size lost is never regained.



Fruit Growth Case Studies





In this orchard at Pozieres there were Hi Early Delicious and Royal Gala apple trees in neighbouring rows. The trees were the same age and had been pruned, thinned, fertilised and irrigated similarly.

⇒ The fruit diameter and fruit growth rate curves show

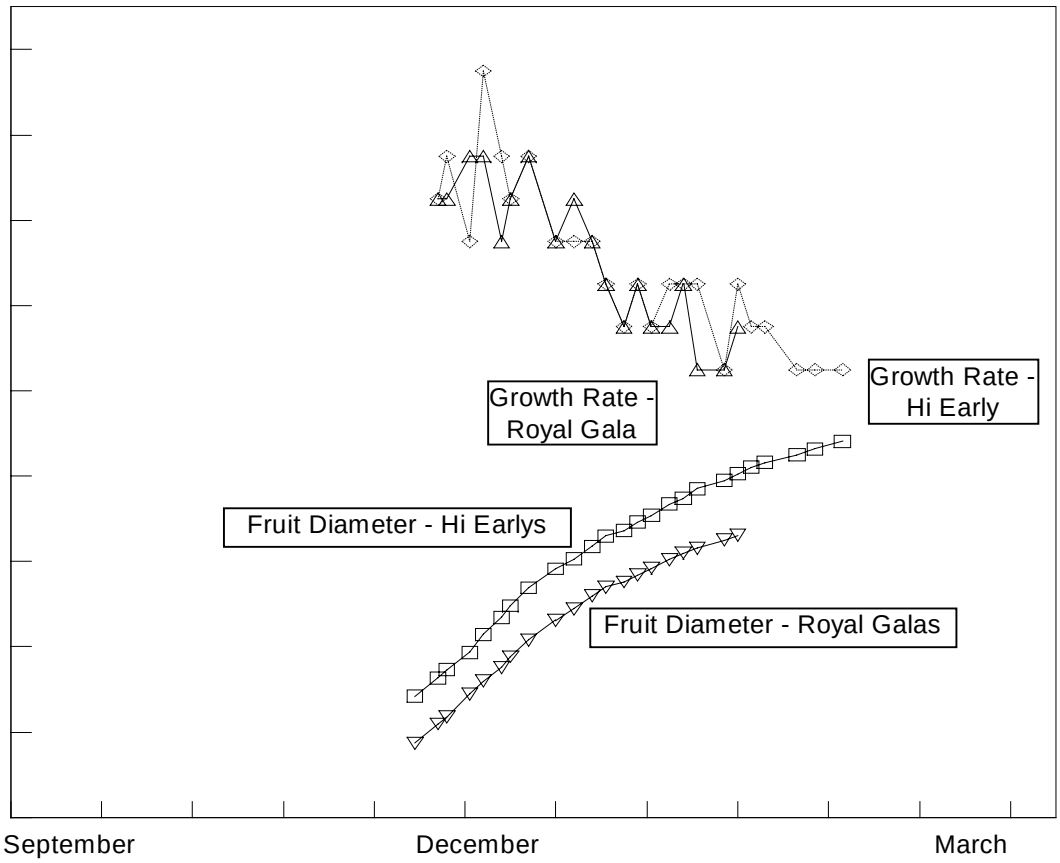
⇒ That the growth rates for both varieties were high and low during the same weeks.

⇒ That generally they fell as the season progressed.

⇒ The Hi Early were always larger than the Gala.

⇒ That the Hi Early apples had higher growth rates than the Galas for some of the time, thus their relative sizes were getting progressively bigger.

Time Graph, Hi Early Delicious & Royal Gala in the Same Block, Pozieres.



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